METHOD FOR THE ROUTING OF IP FRAMES BETWEEN THE USERS OF A VARIABLE GRAPH NETWORK

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a virtual router distributed over a carrier network and a method for the routing of packets among several virtual local area networks relying on a switching network whose graph may be variable owing to the mobility of its nodes.

The expression "distributed virtual router" is used to designate the routing method. The underlying switching network is also known as a "carrier network".

The nodes of the network communicate with one another for example by means of arteries whose configuration or existence may evolve over time, leading to a mobility of the nodes.

The invention can be applied especially to IP format packets of the Internet protocol.

The present invention can be applied for example in ATM type networks.

It can be applied to the emulation of routing in all networks using switching techniques.

2. Description of the Prior Art

In the prior art, the routing is done by means of a piece of equipment known as a router that relays the packets entering a junctor of this equipment towards an output junctor as a function of the destination IP address of the packet and as a function of the routing table.

When the routing is done between a large number of local area networks at very great distances from one another, a meshed network of routers consisting of access routers and transit routers is generally used.

A configuration of this kind has certain drawbacks, especially the following ones:

1) the transit time of a packet in the network is adversely affected by the large number of routers to be crossed,

2) the notion of quality of service (QoS) is not taken into account.

One way to overcome the above-mentioned drawbacks consists for example in integrating the IP routing (level 3) with a switching technology

(level 2) such as the ATM (asynchronous transfer mode) switching. Three lines of development have been emphasized.

For example, what is called the gigarouter technology achieves a routing function at the core of a switch in taking account of the destination IP address in the switching process. In the ATM context, the destination IP address is taken into account during the translation of logic channels.

The label-switching technology identifies the flows within the IP traffic by a process of signalling associated with these flows of labels used by the level 2 switching. Applied to the ATM, a logic path indicator VPI/VCI is associated with a flow. This technology is being standardized at the IETF under the name of multiprotocol label switching (MPLS).

The technology known as "local area network and routing emulation" is used to create virtual circuits that directly connect the communications applications (short circuits) in using a specific protocol that defines customer entities, server entities, connections between these entities and rules for making short circuits between customers. In the ATM context, this technology is covered by a standard known as local area network emulation (LANE) and multiprotocol over ATM or MPOA.

This technology relies on the implementation of essential centralized functions of servers, flow routers with short lifetimes capable of being duplicated or even triplicated to provide minimum redundancy. However, when the network is subdivided into several non-interconnected components, there is no certainty that each component will have all the functions essential to the service nor that when two networks are combined, the redundant functions (offered by each of the components taken individually) will merge harmoniously, namely transparently for the user.

The object of the invention relates especially to a method of routing between virtual local area networks when the underlying switching network has a graph that may be variable owing to the mobility of its nodes, the network possibly being constituted by several components. A component is defined as a sub-network comprising at least two nodes that communicate with each other by arteries.

The number of components may be equal to the numbers of switches of the network.

SUMMARY OF THE INVENTION

The invention relates to a virtual router distributed on a carrier network, said carrier network comprising one or more components, each of the components comprising at least two nodes communicating with one
5 another by means of an artery, a node comprising a FAx access function and server functions (LES/BUS, LECS, MPS). It is characterized in that at least one component of said network comprises the following elements:

. several ELANi-bridges, each ELANi-bridge being connected to a virtual network VLANi,
10 . at least one transit ELAN, Tx,
. at the level of an access function FAx:

. router LEC means Rix adapted to connecting the access function Fax to at least one ELANi associated with a VLANi,
. means (Lx) for the identification of the VLANi serviced by the
15 access function FAx,
. means (LEC transit) to connect the ELAN transit to the access function.

The invention also relates to a method of routing in a switched network comprising one or more components, the component or components
20 comprising at least two nodes connected by a communications artery, each of the nodes comprising an access function FAx. It is characterized in that it comprises at least one step where the access function relays the data packets received on one of the LECs as follows:

(a) if the addressee of the packet is an internal routing function laid out at
25 a node X, the packet is directly handed over to said function,

(b) if the addressee of a packet is a VLAN serviced by the FAx access function, the data packet is relayed to the router having the same identifier,

(c) if the addressee of the packet is a VLAN that is not serviced, the
30 packet is relayed to the transit ELAN.

The step (b) may be carried out as follows:

. if the addressee VLAN with the identifier j belongs to the list Lx, the relaying function of FAx is activated and the data packet is relayed to the LEC router Rjx having an identifier that is the identifier of the addressee VLAN, and
35 the step (c) may be carried out as follows:

. if the addressee VLAN does not belong to the list Lx, the data packet is relayed to the transit LEC mentioned in the routing table.

The use of the virtual router distributed to ATM type supporting networks and IP data packets or IP frame between the users of a variable graph network for example.

The present invention comprises especially the following advantages:

. it provides users of non-interconnected components with a routing service equivalent to the one offered by the complete network,

. in the case of the merger of several components, it enables the merger without redundancy of the functions offered.

BRIEF DESCRIPTION OF THE DRAWINGS

Other features and advantages of the invention shall appear from the following description given by way of an illustration that in no way restricts the scope of the invention, with reference to the appended figures, of which:

. Figure 1 shows a general view of a network,

. Figure 2 shows a general view of the network of Figure 1 after splitting into two components,

. Figure 3 shows an architecture of a switch according to the invention,

. Figure 4 shows an IP access function according to the invention,

. Figure 5 shows an exemplary architecture of a distributed virtual router according to the invention, and

. Figure 6 is an architecture of a router after the splitting of the architecture described in Figure 5.

MORE DETAILED DESCRIPTION

The method according to the invention or "distributed virtual router" is designed especially to offer a routing service among several virtual local area networks or VLANs relying on a switching network whose graph is variable owing to the mobility of its nodes.

Indeed, in the course of time, the switching network is capable of getting split up into numerous non-interconnected components, a component being formed for example by several nodes communicating by means of arteries, and/or of getting extended by the interconnection of such components. At the most, the splitting up of a network may lead to a number of components equal to the number of switches or nodes of the network.

The description given here below by way of a non-restricted illustration relates to an ATM support network and can be applied to the emulation of IP packet routing. It can also be used in all networks implementing other switching and routing technologies.

5   Figure 1 shows a view of an ATM network 1 (level 2) comprising several switches 2 (corresponding for example to the nodes X, Y and Z of the network) and several arteries 3, each of the arteries connecting two switches. This network has the function especially of interconnecting different items of equipment 4 in local area network emulation mode. These

10   different items of equipment 4 fulfill the role of passageways between several ethernet networks 5, referenced Ui, Vi, Uj and Vk to which they are connected and the ATM network 1. Various stations can be connected to each ethernet network.

An ethernet network designated by an identifier i, j, ... is connected to

15   a VLAN designated by the same identifier.

Thus, in the example of figure 1, the networks Ui and Vi correspond to the same VLANi, the networks Uj to the VLANj and the networks Uk, Vk to the VLANk.

The network ATM 1 provides a bridge service according to the prior

20   art, for example between the different networks belonging to one and the same VLAN and a routing service according to the invention, for example between the three VLAN networks VLANi, VLANj and VLANk.

Figure 2 shows a network comprising elements identical to those described in Figure 1 and having the same references, wherein the node X is

25   isolated from the rest of the network. The nodes Y and Z are connected by a communications artery 3. The network has two components, a first component comprising the node X that is insulated and a second component comprising the two nodes X and Y and the communications artery 3.

The object of the invention especially is to propose an adapted switch

30   architecture to provide intercommunication services between the networks within each component, namely the routing between Ui and Vk in the first component and the routing between Vi, Uj and Uk in the second component.

The switch 2 described in detail in Figure 3 comprises for example:

. an access function IP 20 according to the invention described in detail in Figure 4,

. a LES/BUS (LAN emulation server/broadcast or unknown server) function 21,

. a LECS (LAN emulation configuration server) function 22, and

. an MPS (MPOA server) function 23.

The latter three functions are designated in the description for reasons of simplification by the expression "server function" and have characteristics known in the prior art.

Figure 4 gives a detailed view of an exemplary embodiment of a IP access function 20 implanted in a node and having characteristics according to the invention.

This IP access function 20, referenced by the acronym FAx where the index x corresponds to the node concerned, in this case the node X, comprises for example:

. a transit LEC 201 referenced Tx having the index of the node concerned, LEC being the abbreviation of LAN emulation client,

. n router LECs 202 referenced Rix where n is the number of VLANs, i corresponding to the identifier of the VLAN and x to the index of the node concerned,

. a relaying function 203 that receives the IP packet and processes it as a function of its header; for example it modifies the header and re-sends the packet,

. a routing table 204 containing the routing data,

. a routing function 205,

. an election function 206 used to assign the servicing of each VLAN to a single access function, and

. a list Lx 207 of VLANs serviced.

These different elements and their interactions with the network are explained here below.

Transit LEC 201

The ATM support network comprises for example an emulated LAN (ELAN) known as a transit ELAN for which all the IP access functions are clients by means of a LEC function known as a "LEC transit". For example,

the transit LEC function of the access function of the node X is referenced LEC Tx. Those of the nodes Y and Z are respectively referenced LEC Ty and LEC Tz. The transit LEC is connected to the transit ELAN.

Router LEC 202

5   Each VLAN has an associated single emulated LAN in the carrier network. This LAN is called a bridge ELAN. All its access functions are clients by means of a LEC function (LAN emulation client) called a router LEC. A bridge ELAN is designated like the VLANs by an identifier i, j, ...

For example, the IP access function FAx of the node X is a client of
10   each bridge ELAN, ELANi associated with the VLANi by means of the router LEC Rix.

Lx list 207

This list has the function especially of identifying the VLANs serviced by the access function FAx.

15   The constitution of a list Lx is performed for example as follows: for a given component of a network comprising m nodes having an identifier x, y,... and therefore m lists Lm, the intersection any two of the lists Lm corresponds to the empty set.

In the example given in Figures 1 and 5 where the component of the
20   network considered has three nodes referenced X, Y and Z, the corresponding lists Lx, Ly and Lz are determined so that when one of them takes any two of the three lists, their intersection is equal to $\varnothing$. In this example, for the node X, Lx={i, j}, for the node Y, Ly={k} and for the node Z, Lz={}.

25   It is possible to use an election protocol known to those skilled in the art, for example the VRRP protocol standardized at IETF under reference RFC 2338.

The implementation of the election protocol is for example ensured by the election function 206 implanted in each access function FAx, FAy, FAz
30   and engaging in dialog with the corresponding functions of the other nodes forming part of the same component of the network, by exchange of packets on the bridge ELANs through the router LECs Rix mentioned.

Routing and relaying functions and the routing table

The IP access functions, FAx, FAy ... implement a routing function
35   and a relaying function as well as a routing table known in the prior art.

The routing function 205 sustains a routing table 204 by means of a dialog with the homologous routing functions through a routing protocol.

The relaying function 203 enables the relaying of any packet coming from an ELAN towards another ELAN as a function of its destination IP address and of the information contained in the routing table.

From the routing point of view, all the IP access functions of one and the same component are adjacent through the transit ELAN. The routing protocol uses the transit ELAN to broadcast the routing information to the corresponding units towards the bridge ELANs, ELANi, ELANj, ... where i, j belong to the Lx lists defined, using the principle mentioned here above, through the associated router LECs.

A principle of implementation of an access function implanted in the node, for example FAx implanted in the node X, may be as follows:

.   The access function IP FAx relays for example all the IP packets received on the router LECs, LEC Rix where i belongs to Lx on the basis of the destination IP address and the information contained in the routing table.

.   If the destination of the IP packet is a function internal to the access function FAx, such as the election function or the routing function, the IP packet is forwarded directly to this internal function.

.   Else.

    .   If the destination VLAN j for example belongs to the list Lx of the addressee VLANs, the access function FAx activates its relaying function 203 in order to relay the IP packet to the router LEC Rjx of the node x linked with the ELAN j connected to the VLANj.

    .   If the destination VLAN j does not belong to the list Lx, it is not part of the VLANs serviced by the node X, the IP packet is relayed to the transit LEC Tx which sends it on the transit ELAN towards a transit LEC indicated in the routing table (known by the expression "next hop") for example Ty, the transit LEC of the node Y.

.   The router LECs Rmx of the node x where the identifier m does not belong to the list Lx remain inactive, for example Rkx in

Figure 5. In this case, only the destination packets IP of the internal election function are accepted.

.   The access function FAx also relays all the packets IP received on the transit LEC Tx by using the destination address IP and the information contained in the routing table.

.   If the addressee of the IP packet is the internal routing function 205 laid out in the node X, the IP packet is forwarded directly to this function.

.   If the packet is destined for a VLANi serviced by the access function FAx, namely it belongs to the list Lx, the packet is relayed to the router LEC of the access function having an identifier index i of the VLAN and the index x of the node, Rix.

.   If the packet is intended for a VLAN not serviced by the access function (the identifier i of the VLAN does not belong to the list Lx), the access function FAx relays the packet in taking account of the information contained in the routing table 204 to the transit ELAN.

Each VLANm having an identifier m has one or more points of access to the routing service by means of LEC functions of the corresponding bridge ELAN, ELANm, associated with the VLANm. These LEC functions are named "user LEC ".

For example, the VLANi has several LECs designated by LEC Ui, LEC Vi that are physically connected to any nodes of the carrier network, these LECs forming part of the bridge ELAN having an identifier i.

Certain user LECs could be internal to a node of the network when this network provides ethernet access.

Short circuits enabling the exchange of data flows for sufficiently lengthy periods are automatically set up by MPOA (multiprotocol over ATM).

Figure 5 gives an exemplary view of an architecture of the distributed virtual router according to the invention in a component of the network.

The distributed virtual routing function is achieved for example by a community of several IP access functions 20 referenced FAx, FAy, FAz, ... connected to one another in local area network emulation by a transit ELAN 8 and by n bridge ELANs 9 designated ELANi, ELANj, ELANk where n is the number of VLANs and i is the identifier of a VLAN.

In each switch for example the switch X, the transit LEC Tx is connected to the transit ELAN 8 and the router LECs Rix, Rjx, Rkx are each connected to a corresponding bridge ELAN ELANi, ELANj, ELANk.

For the switch Y, the transit LEC is connected to the transit ELAN 8 and each router LEC is connected to the corresponding ELAN Riy at ELANi, Rjy at ELANj, Rky at ELANk.

For the switch Z, the transit LEC is connected to the transit ELAN 8 and each router LEC is connected to the corresponding ELAN Riz at ELANi, Rjz at ELANj, Rkz at ELANk.

The only elements activated are the router LECs Rix such that i belongs to Lx, the list of serviced VLANs being contained in the table 207 (Figure 4).

In the example given Lx={i, j}, Ly={k} and Lz corresponds to the vacant assembly. This architecture is compatible with the network described in Figure 1. The non-activated router LECs are designated by a cross Rkx, Riy, Rjy, Riz, Rjz, and Rkz.

Figure 6 shows an exemplary architecture of the distributed virtual router when the network is subdivided into two components as shown in Figure 2.

The following table describes the table of actions to be performed upon reception of a packet of the node X.

Receiver LEC	Destination packet	Action
<all except LEC Tx>	Election function	Forward to the election function
Rix, Rjx or Tx	Routing function	Forward to the routing function
Rix or Tx	User of ELAN j	Relay towards Rjx
Rix, Rjx or Tx	User of ELAN k	Relay towards Tx (next hop Ty)
Rjx or Tx	User of ELAN i	Relay towards Rix
In all other cases:		Destroy the packet

In all the exemplary embodiments described here above, the carrier network may be a network with level (2) according to the technology known to those skilled in the art.